

Attachment 2

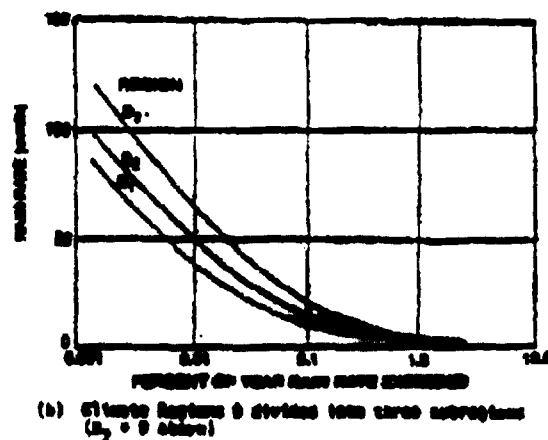
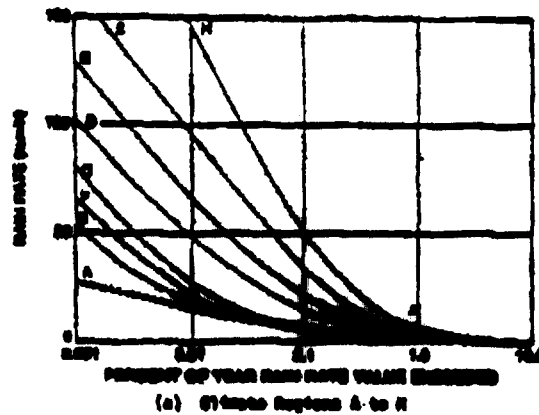
REFERENCE MANUAL FOR TELCOMMUN

13-4.5.6 Point Rain Rate Distribution Values (mm/hr) versus Percentage of Year Rain Rate is Exceeded

Percentage of Year	Rain Climate Region										Minutes per Year	Hours per Year
	A	B	C	D ₁	D ₂	D ₃	E	F	G	H		
0.001	28	34	80	90	102	127	164	56	129	231	3.3	0.09
0.002	24	40	62	72	86	107	144	51	109	220	10.3	0.18
0.005	19	26	41	50	64	81	117	34	85	178	26	0.44
0.01	15	19	28	37	49	63	98	23	67	147	53	0.88
0.02	12	14	18	27	35	48	77	14	51	115	105	1.75
0.05	8	9.5	11	16	22	31	52	8.0	33	77	263	4.38
0.1	6.5	6.8	7.2	11	15	22	35	5.5	22	51	526	8.77
0.2	4.0	4.8	4.8	7.5	9.5	14	21	3.8	14	31	1052	17.5
0.5	2.5	2.7	2.8	4.0	5.2	7.0	8.5	2.4	7.0	13	2630	43.8
1.0	1.7	1.8	1.9	2.2	3.0	4.0	4.0	1.7	3.7	6.4	5280	87.86
2.0	1.1	1.2	1.2	1.3	1.8	2.5	2.0	1.1	1.6	2.8	10320	175.3

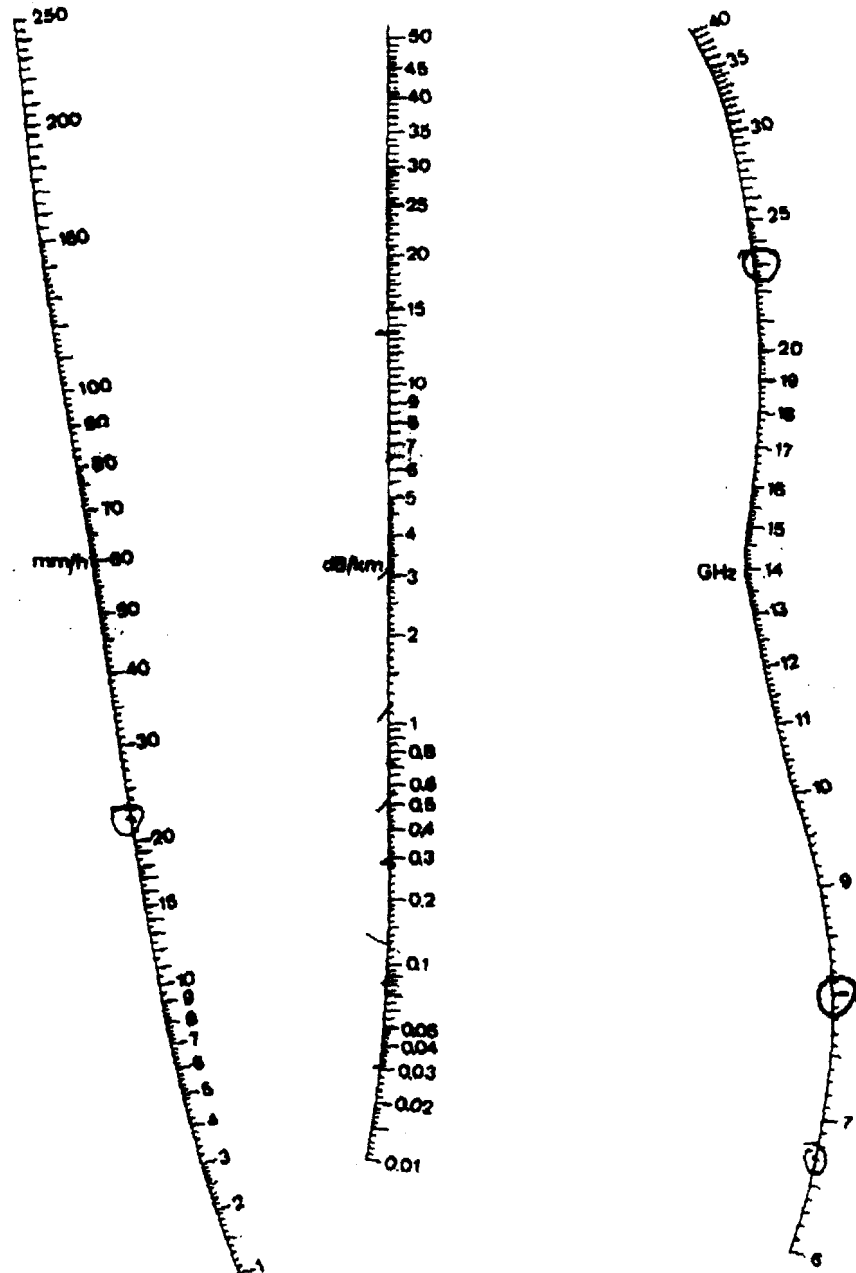
From *A Propagation Effects Handbook for Satellite Systems Design* (Ref. 23), ORJ, Inc., Silver Spring, Md.

13-4.5.7 Point Rain Rate Distributions as a Function of Percentage of Year Exceeded



From *A Propagation Effects Handbook for Satellite Systems Design* (Ref. 23), ORJ, Inc., Silver Spring, Md.

Attachment 3



Specific attenuation γ_R due to rain

Raindrop size distribution [Laws and Parsons, 1943]
 Terminal velocity of raindrops [Gunn and Kinzer, 1949]
 Index of refraction of water at 18° C [Ray, 1972]
 Spherical drops

Georgia Institute of Technology
Georgia Tech Research Institute

BIOGRAPHICAL SKETCH

BARNHART, ERIC N.--Division Chief

Communications and Networking Division

Information Technology and Telecommunications Laboratory

Education

M.S.E.E., Georgia Institute of Technology

1985

B.E.E., Auburn University

1982

Employment History

Georgia Institute of Technology

Chief, Communications and Networking Division

1993-Present

Director, Communications Laboratory

1991-1993

Associate Chief, Communications Systems Div.

1989-1990

Head of Communications Countermeasures Branch

1988-1989

Senior Research Engineer

1990-Present

Research Engineer II

1986-1990

Research Engineer I

1983-1986

Martin Marietta Aerospace, Orlando Division

Engineering Aide

1979-1981

Experience Summary: Has administrative, technical and budget responsibility for the Communications and Networking Division. Presently oversees sponsored programs in commercial telecommunications and military C3I systems and countermeasures. Responsible for the development and management of GTRI systems and technology programs related to these research areas. Is a member of the staff of the Georgia Center for Advanced Telecommunications Technology (GCATT). Currently is involved in the investigation of indoor propagation and the development of Personal Communications Network (PCN) services and equipment. Is also currently involved in development of interactive cable system trial for distance learning. Recently involved in the development of adaptive, spread-spectrum communications systems and techniques. Also investigated cosite interference mitigation techniques. Has conducted vulnerability analysis and testing of multichannel secure communications systems for tactical and strategic applications. Has experience in the performance analysis and operational testing of intercept systems, and foreign equipment exploitation and analysis. Has experience in the analysis and computer modeling of coded, spread-spectrum digital communications systems to investigate system vulnerability with respect to interception and disruption by jamming. Has experience with propagation analysis/modeling from HF through millimeter-wave frequencies, threat evaluation and wideband signal processing. Has hardware design experience with discrete digital systems, and hardware/software development experience with microprocessor based systems. Also has worked on systems integration, calibration, and testing of millimeter-wave radar seeker/guidance systems and temperature control systems. Active as a consultant to government and industry.

Current Fields of Interest

Wireless/personal communications; broadband interactive systems; telecommunications/economic development; networks for enterprise integration, distance learning and telemedicine; multimedia and client-server systems and architectures; military communications; communications privacy/security; telecommunication systems and networks; data communications; lightwave communications; intercept/surveillance systems and techniques; countermeasures systems and techniques; communication system vulnerability; modeling; simulation; signal processing.

Registrations and Special Honors

Registered Professional Engineer, Georgia
General Chairman, 1993 National Telesystems Conference
Wireless Technology Consultant, Sun Features/L.A. Times Syndicate
National Science Foundation Small Business Innovative Research (SBIR) Proposal Review Board in Communications and Networking
Scientific Advisory Board - International Tele-Marine Corporation
Telecommunications Technology Consultant to Caribbean Association of National Telecommunications Organizations (CANTO)
Member: IEEE, IEEE Communications Society, Communications Systems Engineering Committee, Radio Communications Committee, Vehicular Technology Society, Aerospace and Electronic Systems Society, Society of Photo-Optical Instrumentation Engineers, Association of Old Crows, Armed Forces Communications Electronics Association, Tau Beta Pi, Eta Kappa Nu, IVHS America

Major Reports and Publications

1. "An Analysis of Millimeter-Wave Wireless Local Area Networks for LPI/AJ Command Post Communications," Proceedings of the 1993 Military Communications Conference, Boston, Massachusetts, October 1993, coauthor
2. "Distance Learning Via a Caribbean Teleconference Network," Record of the CANTO 1993 Conference and Trade Exhibition, Oranjestad, Dutch Caribbean, June 1993
3. "A Proposed Vocational Education Network: Training, Economic and Technical Implications," Proceedings of the 15th Pacific Telecommunications Conference, Honolulu, Hawaii, January 1993
4. "Trends in Multipath Delay Spread from Frequency Domain Measurements of the Wireless Indoor Communications Channel," Proceedings of the Third International Symposium on Personal, Indoor and Mobile Radio Communications, Boston, Massachusetts, October 1992, coauthor
5. "Mathematical Expressions and Algorithms for Cell Evaluation Tool," Final Report, Project A-9065-200, September 1992, coauthor
6. "Interim Technical Report Number 1: Experimental Licenses KK2XBA and KK2XBB," Interim Report, Federal Communications Commission, August 1992, coauthor

7. "Georgia: Well-Positioned for the Telecommunications Revolution," Computer Currents Magazine, Vol. 4, No. 8, August 1992
8. "Prototype Implementation of an EHF Switched-Beam Array Controller," Final Report, Project A-8200, August 1992, coauthor
9. "Propagation Characterization in Support of BellSouth Personal Communications Services Development," Final Report, Project A-9041, April 1992, coauthor
10. "Propagation Measurements in Support of Hitachi Wireless Communications Model Development," Final Report, Project A-9065-100, March 1992, coauthor
11. Full Speed Ahead for Wireless Access Systems," Guest Expert Section, Computer Currents Magazine, Vol.3, No.10, October 1991
12. "Statistical Data from Frequency Domain Measurements of the Indoor PCN Communication Channel," Proceedings of the IEEE International Symposium on Personal, Indoor and Mobile Radio Communications, London, England, United Kingdom, September 1991, coauthor
13. "Test Plan for Hitachi In-Building Communications Channel Characterization," Interim Report, Project B-699, August 1991, coauthor
14. "GUARDRAIL/Common Sensor Upgrade and Environment Analysis," Final Report, Project A-8418, June 1991, coauthor
15. "Electronic Warfare Vulnerability Assessment Process Demonstration Design," Proceedings of the Georgia Tech ECCM Workshop, Atlanta, Georgia, April 1991, coauthor
16. "Characterization of Propagation in Support of Personal Communications Services Development," Final Report, Project A-8756, April 1991, coauthor
17. "Advances in Wireless Communications Systems and Technology," Conference Record of SOUTHCON/'91, Atlanta, Georgia, March 1991
18. "Characterization of Indoor Propagation for Personal Communications Services," Conference Record of SOUTHCON/'91, Atlanta, Georgia, March 1991, coauthor
19. Equipment Design and Measurement Plan for Propagation Characterization in Support of Personal Communications Services Development," Interim Report, Project A-8756, November 1990, coauthor
20. "EHF Switched-Beam Array Design" Interim Report, Project A-8200, November 1990, coauthor
21. "Independent Assessment of Radio Propagation Losses in the Raytheon C1 Model and the CECOM MSE and JTIDS System Performance Models," Final Report, Project A-8653, August 1990, coauthor
22. "Millimeter Waves for Communications," International Conference on Millimeter-Wave and Far-Infrared Technology, Beijing, China, June 1990
23. "Millimeter-Wave Antennas and Receivers," Final Report, Project A-4070-400, May 1990, coauthor
24. "EURODEMO Data Analysis," Final Report, Project A-8373, March 1990
25. "Millimeter Wave Direction Finding Using Switched-Beam Array Technology," 14th International Conference on Infrared and Millimeter Waves, Wurzburg, West Germany, October 1989
26. "Application of ACT Devices To Cosite Interference Reduction", Final Report, ECSL Internal Research, September 1989, coauthor

27. "Switched-Beam Array Antenna, "Interim Report, Project A-4070-400, June 1989, coauthor
28. "Analysis of REGENCY NET Access by a Follower Jammer," Final Report, Project A-8191, May 1989, coauthor
29. "REGENCY NET Jamming Vulnerability Issues and Electromagnetic Compatibility Tests," Interim Report, Project A-8191, March 1989, coauthor
30. "REGSIM Evaluation Results," Interim Report, Project A-8191, January 1989, coauthor
31. "Cosite Interference Reduction," Final Report, Project A-8063, January 1989, coauthor
32. "Specialized Engineering for Special Operations Forces," Final Report, Project A-4965, November 1988, coauthor
33. "Adaptive Signal Masking Techniques," 1988 Military Communications Conference, San Diego, CA, October 1988, coauthor
34. "Susceptibility Testing of an HF, Multichannel, Secure Communications System," Final Report, Project A-4526, April 1988, coauthor
35. "JTIDS Siting Analysis," Final Briefing, Project A-4918-200, April 1988, coauthor
36. "Avionics Configuration Analysis Program (ACAP)--Functional Description," Interim Report, Project A-4965-700, April 1988, coauthor
37. "Adaptive Signal Masking Techniques," Interim Report, Project A-4626, February 1988, coauthor
38. "Air-to-Air Applications for Millimeter-Wave Communications," 12th Annual International Conference on Infrared and Millimeter Waves, Orlando, Florida, December 1987
39. "Millimeter-Wave Communications: Air-to-Air Applications," 1987 SPIE Technical Symposium Southeast, Orlando, Florida, May 1987
40. "VALLTOSE Program," Final Report, Project A-4427, January 1987
41. "Direction Finding Capabilities," Final Report, Project A-4216, June 1986, coauthor
42. "Adaptive Thresholding: A Detection Technique for Wideband Large-Sector Intercept Systems," 1986 Tactical Communications Conference, Ft. Wayne, Indiana, April 1986
43. "GRANITE ICE Communications Equipment Exploitation and Analysis," Final Report, Project A-4227, March 1986, coauthor
44. "VALLTOSE Task 1: Detection Techniques," Final Report, Project A-4029, November 1985, coauthor
45. "An Examination of the LPI Characteristics of EHF Air-to-Air Communications Systems," 1985 Military Communications Conference, Boston, Massachusetts, October 1985, coauthor
46. "Evaluation of the AJ/LPI Performance of an EHF Air-to-Air Communications System," Final Report, Project A-4041, May 1985, coauthor
47. "Threat Evaluation for JTIDS Radios Used for PATRIOT Communications," Final Report, Project A-3936, January 1985, coauthor
48. "ABIT Data Link Threat Assessment," Final Report, Project A-3054-420, January 1985, coauthor
49. "Performance of EHF Communications Systems in the Presence of Jamming," 1984 Military Communications Conference, Los Angeles, California, October 1984, coauthor

Revised November 1993

RESUME

Roger L. Freeman

**P.O. Box 259
Sudbury, MA 01776**

Tel: 508-443-6949

OBJECTIVE: Technically challenging short and medium-term positions as an independent telecommunication consultant.

EXPERIENCE SUMMARY

Over 25 years experience in complex telecommunication system design and operation. Engineered and managed:

- digital telephone networks - data/integrated networks
- digital switching and transmission - routing and signaling
- telecommunications planning - outside/inside plant
- transmission techniques include:
 - LOS microwave
 - wire-pair
 - HF
 - satellite systems
 - coaxial cable
 - meteor burst
 - fiber optics
 - troposcatter
 - VHF/UHF mobile

International experience:

- Europe and Hispanic America
- International agencies such as CCITT/CCIR/ITU
- InterAmerican Development Bank - PTTs

Secret clearance, previously top secret.

SPECIFIC BACKGROUND

1/92 to Present: Independent consultant in telecommunications. Various clients. Specializing in telecommunication systems (transmission and switching) and data networks; survivability issues; new business development.

7/78 to 12/91: Raytheon Company, Communication Systems Directorate, Marlborough, MA.

Principal Engineer, Advanced System Planning. Responsible for new business development for advanced military communication systems.

- Adapted advanced commercial telecommunication practice to the military environment.
- Prepared corporate position papers on technical issues such as:
 - commercial satellite communications for military application
 - BISDN/ATM in the tactical environment
 - OC-1 and OC-3 over millimeter wave radio
 - MBC system experiments for the U.S. Army
- Advised other Raytheon divisions/directorates on commercial telecommunication practice such as Nexrad and Ramp.

4/70 to 7/78: ITT Laboratories, Spain (Madrid)
Staff consultant, telecommunication planning. Advised on transmission and signaling planning.

- Prepared/published ITT's "Telecommunication Planning Guides."

- Managed planning projects in Hispanic America and Europe.
- Managed ITT Marine (technical) for three years - saw 50% increase in GOR

PRIOR EXPERIENCE

Page Communications Engineers, Washington, D.C. Staff engineer for Hispanic American programs.

International Telecommunication Union (Geneva) Regional Planning Expert for northern South America based in Quito, Ecuador.

ITT Communication Systems - member of technical staff, military communication system design.

EDUCATION: Bachelors and Masters degrees, New York University.

OTHER BACKGROUND INFORMATION

Memberships:

- Senior member, IEEE and candidate for fellow.

Special activities:

- Guest editor, IEEE Communications magazine, special issue on Desert Storm communications (Jan. '92).
- Session organizer/chairman, MILCOM '89 and '90.

Languages:

- Fluent in Spanish, particularly technical Spanish.

Publications:

- Authored and published over 15 articles in international technical journals dealing with various disciplines of telecommunications.
- Authored and published four related textbooks:
 - "Reference Manual for Telecommunication Engineering," Wiley NY 1985
 - "Radio System Design for Telecommunications," Wiley NY 1987
 - "Telecommunication System Engineering," 2nd edition, Wiley NY 1989
 - "Telecommunication Transmission Handbook," 3rd edition, Wiley NY 1991.

Prepared seminars and taught:

- "Telecommunication Transmission Systems," taught in Spanish, Quito Polytechnic University 1967-1969.
- "Radio System Design," "Telecommunication System Engineering" and "Telecommunication Transmission Techniques" at the University of Wisconsin - Madison.

Teacher-of-the-year, Northeastern University, 1987.

BERNARD B. BOSSARD

EDUCATION: Virginia Military Institute, BSEE

EMPLOYMENT BACKGROUND:

1990-Present

Partner, CellularVision, Inc.

1977-1990

President, I/TTIC

Designed packet switch and microwave communications network under two contracts totaling over \$4,000,000.

Senior Vice President and Group Publisher, Horizon House-Microwave, Inc.
Responsible for the publication of Microwave Journal, The Journal of Electronic Defense, and Telecommunications magazines. These publications had a circulation of 200,000 plus).

1973-1977

Manager, M/A-COM (KMC Division)

Focus on development in research, development and application of new products. Upon leaving M/A-COM a non-competitive agreement prevented employment in microwave industry for a period of time.

1970-1973

General Manager, KMC Semiconductor Corp.

KMC was the first company to manufacture transistor (above 1 GHz). In addition to transistors, KMC produced tunnel diodes, back diodes, varactors, solid state amplifiers and small sub-systems. The company was purchased in 1973 by M/A-COM (Microwave Associates) and is now part of their semiconductor operation.

Developed high dynamic range interference reduction circuits and target identification techniques for U.S. government.

Co-developed key Patriot Missile interference reduction device.

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Bernard Bossard

EMPLOYMENT BACKGROUND continued:

1968-1970

President, National Electronic Laboratories

**Founder of electronic company engaging in research and development of solid state devices
The company merged with KMC Semi-conductor Corporation in 1970..**

Consultant for Engleman Microwave and KMC Semiconductor Corp.

1959-1968

Group Leader, RCA Communications

**Responsible for a group of engineers engaged in research and development contracts
in microwave communications. various solid state devices, system engineering, signals in
noise, laser, super conductors and interference reduction devices.**

1957-1959

Engineer, United States Army Research Laboratories

**Developed low noise parametric amplifiers, anti-jamming techniques, millimeter wave
radar and target identification radar.**

TECHNICAL BACKGROUND:

1. Technical Leader of Research and Development:

- a) Interference reduction technology**
- b) Anti-Jamming concepts**
- c) Super conductors**
- d) Parametric amplifiers**
- e) High level convertors**
- f) High "Q" filters**
- g) Linear receivers**
- h) Major communications system designs**
- i) Solid state devices**
- j) Solid state multipliers and oscillators**
- k) sub systems for governmental applications**
- l) Laser modulation television**

**2. Low noise amplifier advisor to Dynsoar, Relay Satellite, and Lunar Excursion Radar
Module**

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Bernard Bossard

TECHNICAL BACKGROUND continued:

3. Consultant to U.S. Government on Radar Target Identification Techniques
4. Developed the first published parametric amplifiers with voltage gain bandwidth products as large as 1300 at S-band and tunable parametric amplifiers with noise figures of 1.0 dB
5. Developed first published high level parametric upconverter theory and device
6. Co-developed filter concepts which result in unloaded "Q" at 100,000 at room temps
7. Co-developed interference reduction techniques which improve receiver intermodulation distortion performance by 50 dB.
8. Developed linear voltage tuning, broadband high power and high efficiency varactor multipliers for use throughout the microwave region
9. Developed 130 dB dynamic range (-3 dB compression and 1 MHz bandwidth) frequency converters
10. Developed superconducting "X" band filter and amplifiers
11. Designed cellular Television system for commercial use
12. Co-developed critical Patriot Missile module (thousands used per receiver)
13. Expert witness on radar in court for the states of New Jersey and Massachusetts
14. Co-designed TRC-97
15. Program leader for numerous RCA internal research and development projects and government research contracts

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Bernard Bossard

AWARDS:

Nominated by RCA for Outstanding Young Engineer in America given by Eta Kappa Nu, National Engineering Honorary Society, 1966

U.S. Government Sustained Superior Performance Award, 1959

Team Engineering Award, RCA

Zero Defects Award, RCA

OTHER:

Chairman, Monolithic Circuits Sessions, MTT's Symposium, 1988

Lecturer, Satellite Communications, Northeastern University, 1986

Guest Lecturer on superconductors, National Science Foundation, University of Colorado, 1965

Guest Lecturer on noise and intermodulation distortion, University of Pennsylvania, 1964-65

Guest Lecturer on low noise technique at Stanford University, Georgia Institute of Technology and Pratt Institute of Technology

Who's Who in the East

Member, Board of Directors of several communications and microwave companies

Guest Lecturer, Communications Systems

PATENTS ISSUED:

Superregenerative Reactance Amplified Number 3,045,115 United States

Variable Frequency Oscillator Number 3,102,978 United States

Low Power Multi-Function Cellular Television System Number 4,747,160 United States and Foreign

PUBLICATIONS AND PRESENTATIONS:

1. Bossard, B. "Superregenerative Reactance Amplifier", Proc. IRE
Volume 47, PP 1269-1271 July 1959
2. Bossard, Frost, Fishbein, "X-Brand Superregenerative Paramp", Pro.IRE, July 1960
3. Pettai, Bossard, Weisbaum, "Single Diode Parametric Upconverter with Large Gd in
Bandwidth Product", Proc. IRE, Volume 48, July 1960
4. Bossard, Pettai, "Broad Parametric Amplifiers by Simple Experimental Techniques",
Proc. IRE, Volume 50, March 1961
5. Perlman, Bossard, "Efficient High Level Parametric Frequency Convertors", Proc.
IEEE, Volume 51, February 1963
6. Bossard, Pettai, "Broadband Parametric Amplifiers", PGMTT Symposium, Bolder,
Colorado, 1962
7. Bossard, Pettai, "Parametric Amplifiers", AIEE Convention (Invited Paper) 1962
8. Bossard, Kurzrok, "Comments on Broadband Parametric Amplifiers", Proc. IRE,
Volume 50, October 1962
9. Bossard, "Low Noise Microwave Amplifiers", RCA Engineer, 1963
10. Bossard, Perlman, "Tunable Solid State Microwave Power Source", SWITEGO,
1963
11. Perlman, Bossard, "Efficient High Level Parametric Frequency Converters", Part III
IEEE National Convention Record, 1963
12. Bossard, Mehman, Newton, "One Watt Tunable Solid State Power Source for the
4.4 to 5.0 GHz Communications Band", East Coast Navigational Electronics
Conference, 1963
13. Pan, Bossard, Burns, Chang, "Systems Concepts of Microwave Communications",
NEREM (Invited Paper) 1964

PUBLICATIONS AND PRESENTATIONS continued:

14. Bossard, Torrione, Yuan, "Theory and Improvement of Intermodulation Distortion in Mixers", Tri Service Electromagnetic Compatibility Conference, 1964
15. Pan, Bossard, Yuan, Becker, Torrione, "Receiver Distortions and Reductions", University of Pennsylvania, Summer Lecture Series, 1965
16. Pan, Bossard, Yuan, Becker, Torrione, "Systems Concepts of Radio Interference", University of Pennsylvania, Summer Lecture Series, 1964
17. Bossard, "Communications Applications of Cryogenic Techniques", National Science Foundation, University of Colorado, Summer Lecture Series, 1965
18. Perlow, Bossard, "High "Q" Filter Using Feed Forward Techniques", SWIEECO, Dallas, Texas, 1966
19. Perlow, Bossard, "Effective Receiver Dynamic Range Enhancement", Frequency 1966
20. Perlow, Torrione, Bossard, "Balloon Communication System", RCA Engineer, 1966
21. Bossard, "Effective Receiver Dynamic Range Enhancement", Frequency, 1966
22. Bossard, "Single Frequency Radar Concept", Pratt (Invited Lecture Series) 1965
23. Guest of Honor, Pratt University ETA Kappa Nu and Tsu Beta Pi, Graduation 1965
24. Bossard, Markard, Levine, "Co-Channel Intermodulation and Cross Modulation Reduction Circuit", Proc. IEEE, December 1967
25. Bossard, Communication Systems, Northeastern University, Lecture Series, 1986
26. Bossard, "Microwave Solid State Devices", Boston Chapter, PGMITT, Invited Speaker, April, 1970
27. Perlow, Bossard, "Microwave Transistor Specifications", Microwaves, July, 1970

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Bernard Bossard

PUBLICATOINS AND PRESENTATIONS continued:

28. Bossard, "Emerging Technologies" Tela-Strategies, Guest Speaker, Washington, DC
December 1991
29. Bossard, Emerging Technology, SCTE, New Orleans, LA, Guest Speaker, Jan. 7, 1993
30. Bossard, Mercer College, Guest Speaker, March 29, 1993
31. Bossard, Virginia Military Institute, Guest Speaker, April 16, 1993
32. Bossard, Optical Fiber Conference, Phoenix, AZ, Guest Speaker, March 11, 1993
33. Bossard, Satellite and Terrestrial Communications, Society of Satellite Professionals,
New York, NY, Guest Speaker, March 31, 1993
34. Bossard, Wireless Communications, Guest Speaker, Washington, DC April 1, 1993
35. Bossard, Fordham University Media Club, Guest Speaker, April, 1993
36. Bossard, Millimeter Wave Communications, Canadian Television Assoc., Toronto, Canada
May 12, 1993
37. Bossard, Conference on Vehicular Technology, Guest Speaker, May 18, 1993
38. Bossard, Cable Television Lab, Brickenridge, Colorado, Guest Speaker,
July 27, 1993
39. Bossard, Wireless Local Loop Cornex Conference, London, England, Guest Speaker,
October 1993